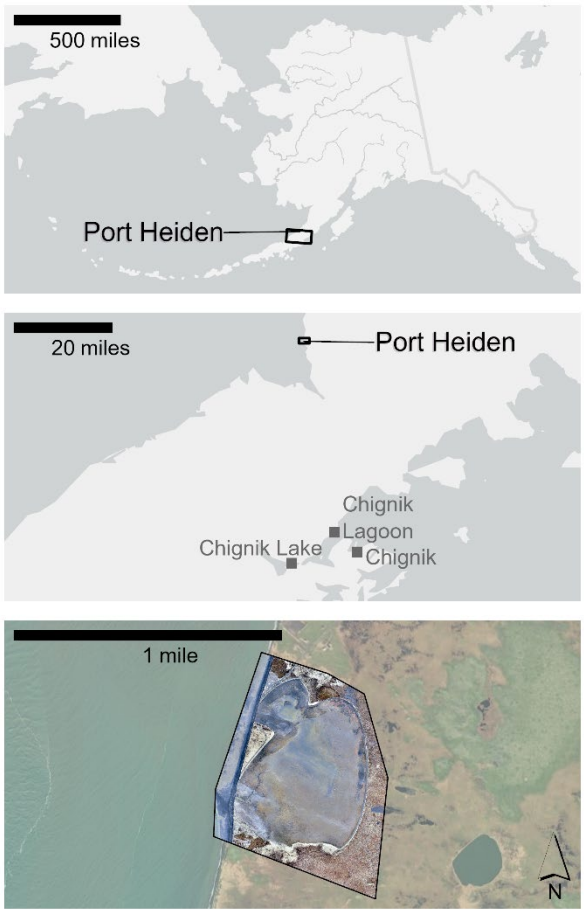
PHOTOGRAMMETRY-DERIVED ORTHOIMAGERY AND ELEVATION FOR GOLDFISH LAKE IN PORT HEIDEN, ALASKA, COLLECTED MAY 7, 2021

Richard M. Buzard, Roberta J.T. Glenn, Katie Y. Miller, and Jacquelyn R. Overbeck

Raw Data File 2021-19



Location map of survey area with orthoimage.

This report has not been reviewed for technical content or
for conformity to the editorial standards of DGGS.

2021
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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Suggested citation:
Buzard, R.M., Glenn, R.J.T., Miller, K.Y., and Overbeck, J.R., 2021, Photogrammetry-derived orthoimagery and elevation for Goldfish Lake in Port Heiden, Alaska, collected May 7, 2021: Alaska Division of Geological & Geophysical Surveys Raw Data File 2021-19, 4 p. https://doi.org/10.14509/30792

PHOTOGRAMMETRY-DERIVED ORTHOIMAGERY AND ELEVATION FOR GOLDFISH LAKE IN PORT HEIDEN, ALASKA, COLLECTED MAY 7, 2021

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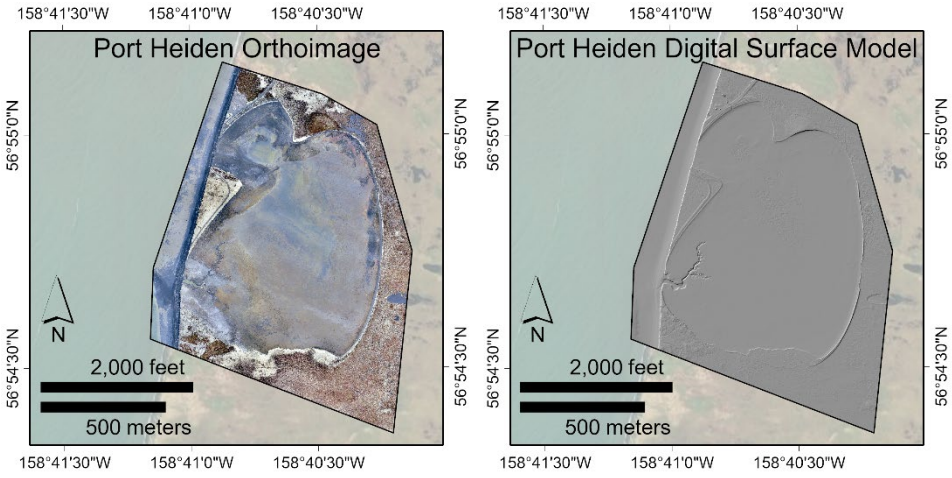
INTRODUCTION

The State of Alaska Division of Geological & Geophysical Surveys (DGGS) collected low-altitude aerial images from an unmanned aerial vehicle (UAV) on May 7, 2021 and used Structure-from-Motion (SfM) photogrammetry to produce a digital surface model (DSM) and orthoimage of Goldfish Lake in Port Heiden (fig. 1). The orthoimagery and elevation data are for assessing coastal hazards and changes. We used Trimble Business Center to process the Global Navigation Satellite System (GNSS) data used for positional control. We used Agisoft Metashape to process the photogrammetry data. These products are released as a Raw Data File with an open end-user license. All files can be downloaded from doi.org/10.14509/30792 or elevation.alaska.gov.

LIST OF DELIVERABLES

- Orthoimage
- Digital Surface Model (DSM)
- Metadata



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MISSION PLAN

Aerial Photogrammetric Survey Details

DGGS used a DJI Phantom 4 RTK UAV with a FC6310R camera model (8.8 mm lens) to collect 20-megapixel JPEG photographs (5472 x 3648 pixels per image). We flew the aerial survey with 70 percent sidelap and 80 percent frontlap, 100 m above the ground at 6.0 m/s, with the nadir camera orientation stabilized by a 3-axis gimbal. The resulting images cover 1.50 km^2 with ground sampling distance (GSD) of approximately 0.03 m.

Weather and Photo Conditions

DGGS conducted flights on May 7, 2021, from 4:30 to 7:20 PM AKDT. The operator returned the UAV six times to change batteries. The weather was overcast with no rain and moderate wind. No abnormalities were observed during the flights.

SURVEY AND PROCESSING REPORT

Ground Survey Details

DGGS set up a GNSS base station using a Trimble R10 receiver sampling at 5 Hz. The base was installed over a temporary benchmark of unknown position. This provided real-time kinematic (RTK) corrections to the UAV and Trimble R8s GNSS receiver. DGGS measured 27 photo-identifiable points with the R8s. We derived the corrected base position using the Online Positioning User Service (found at www.ngs.noaa.gov/OPUS/) and post-processed the R8s positions in Trimble Business Center.

Photogrammetric Dataset Processing

The UAV did not maintain RTK connection with the Trimble R10 base station. We apply a post-processing kinematic correction using RTKLIB (an open-source GNSS processing software found at www.rtklib.com). The UAV GNSS receiver samples at 5 Hz, rather than at image acquisition times. We interpolate the corrected positions at image timestamps to derive coordinates. The image timestamp metadata also contains orientation to support the lever arm correction that adjusts coordinates from the GNSS receiver to the camera. We compute the interpolation and lever arm correction using the worksheet found at www.aerotas.com/phantom-4-rtk-ppk-processing-workflow.

DGGS processed images in Agisoft Metashape Professional software (Version 1.6.3 build 10732). We masked image corners where shadows and image warping were disruptive. Processing steps included aligning images, identifying ground control points (GCPs), manually cleaning the sparse point cloud, optimizing the bundle block adjustment (refining camera positions and lens distortion parameters), constructing the dense point cloud, building the DSM, and creating the orthomosaic image. We used six GCPs to create the model, leaving twenty-one survey check points.

Orthoimagery

The orthoimagery is a three-band (red, green, blue) 8-bit unsigned GeoTIFF file with a GSD of 0.033 m per pixel and the "No Data" value is set to 0.

Digital Surface Model

The DSM represents surface elevations such as the height of vegetation and buildings. The DSM is a single-band, 32-bit floating point GeoTIFF file with a GSD of 0.065 m and the "No Data" value is set to -3.4028231 x 10^{38}.

ACCURACY REPORT

Coordinate System and Datum

All data are processed and delivered in NAD83 (2011) UTM Zone 4N and vertical datum NAVD88 (GEOID12B).

Horizontal Accuracy

We quantify the horizontal accuracy of the DSM and orthoimage by comparing the known locations of 21 photo-identifiable check points measured with GNSS against their modeled locations in the photogrammetric products (fig. 2). X and Y errors are calculated as the root-mean-square (RMS) error of offsets. The total horizontal error is the root-sum-square error of X and Y RMS errors, 0.049 m (table 1).

Vertical Accuracy

We assess the vertical accuracy of the DSM using the same check points. The RMS error of Z offsets is 0.049 m (table 1). The total error of the DSM (X, Y, and Z) is 0.069 m.

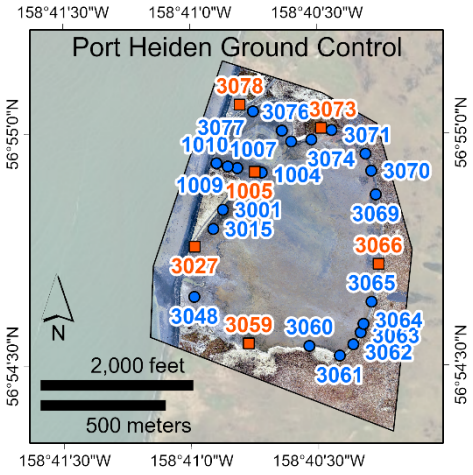

Figure 2. Location of photo-identifiable ground control points (GCPs; red) and check points (CHK; blue).

Table 1. Check point coordinates and offsets from orthoimage and DSM.

Check Point	Easting	Northing	Elevation (m NAVD88)	X Offset (m)	Y Offset (m)	Z Offset (m)
1004	519565.694	6307999.641	18.973	0.015	-0.004	-0.071
1007	519467.788	6308017.059	19.148	0.007	-0.061	-0.090
1009	519429.542	6308023.825	19.301	0.003	-0.068	-0.071
1010	519384.870	6308036.261	19.388	0.017	-0.034	-0.063
3001	519410.714	6307851.375	19.190	-0.007	-0.027	-0.025
3015	519371.524	6307775.119	18.856	0.067	0.031	-0.005
3048	519296.701	6307503.291	19.264	0.077	-0.055	0.011
3060	519756.296	6307307.814	18.964	-0.020	0.038	-0.004
3061	519877.633	6307268.859	19.724	-0.023	0.019	0.045
3062	519931.375	6307314.196	19.768	0.038	-0.010	0.073
3063	519960.766	6307361.446	19.568	0.013	0.000	0.044
3064	519972.346	6307395.944	19.215	-0.053	-0.020	0.041
3065	520004.125	6307484.118	19.318	-0.017	-0.019	0.050
3069	520020.906	6307912.950	19.246	-0.005	-0.009	-0.046
3070	520003.594	6308007.939	19.208	-0.015	-0.071	0.018
3071	519980.118	6308074.964	19.259	-0.013	-0.007	0.040
3072	519844.867	6308169.595	19.488	-0.056	0.021	0.085
3074	519763.761	6308131.804	19.026	-0.027	0.007	0.007
3075	519683.178	6308123.577	19.084	-0.051	0.002	-0.014
3076	519645.630	6308167.102	19.025	-0.035	0.043	0.032
3077	519530.481	6308243.563	19.059	0.016	-0.015	0.038
			Mean	-0.003	-0.011	0.005
			Standard Deviation	0.035	0.033	0.050
			Range	0.133	0.114	0.175
			Root Mean Square Error	0.035	0.034	**0.049**
			Total Error	**0.049 (XY)**		**0.069 (XYZ)**

Data Consistency and Completeness

DGGS visually inspected the orthoimage for data errors such as shifts, seamline mismatches, and water noise overlapping land. There were no significantly erroneous areas that required repair. Visual errors common to these SfM photogrammetry products include discontinuous powerlines, blurriness near high-angle features like buildings, and distortion at water boundaries. Bright objects like metal roofs and white paint can cause overexposure, leading to spurious elevation points.

ACKNOWLEDGEMENTS

We thank the Bristol Bay Native Association for funding the creation of these data products with a Bureau of Indian Affairs Tribal Resilience Program grant and the City of Port Heiden for assistance in carrying out the survey.